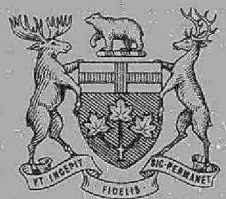

ONTARIO

Ministry of the ENVIRONMENT

Aquatic Plant Growths in Lake Couchiching

1972

Environment Ontario

AQUATIC PLANT GROWTHS

IN

LAKE COUCHICHING

by

M. Jones and D. Veal

Biology Section
Water Quality Branch
Water Resources Division

ONTARIO MINISTRY OF THE ENVIRONMENT

1972

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
DESCRIPTION OF STUDY AREA	2
SAMPLING METHODS AND LOCATIONS	3
RESULTS	6
DISCUSSION	13
Plant Control	17
SUMMARY	19
RECOMMENDATIONS	20
ACKNOWLEDGEMENTS	21
BIBLIOGRAPHY	22
APPENDIX I (Description and Photographs of Major Plant Types)	24
APPENDIX II (Tabulation of Plant Types and Densities Found at Each Sampling Location)	30

INTRODUCTION

During 1971, the Ministry of the Environment (then Ontario Water Resources Commission) conducted a water-quality survey of the Lake Simcoe basin. Part of this study involved an assessment of aquatic plant growths (i.e. macrophytes) throughout the Lake. The resulting report entitled "Aquatic Weed Growths in Lake Simcoe", provided meaningful information on the ecology of Lake Simcoe and will be used in the future to direct water management policies (e.g. vegetation cropping, fish management).

In 1972, the study was expanded to include the watershed area draining into Lake Simcoe, as well as the interconnecting Severn Waterway (including Lake Couchiching) between Lake Simcoe and Georgian Bay. The results of this expanded study will provide data for a management policy designed to maintain the existing high quality of waters in Lakes Simcoe and Couchiching.

It was decided to assess the extent and type of vegetation growth in Lake Couchiching as part of the 1972 watershed survey. Lake Couchiching, because of its geographical location and water quality, is an important recreational area. It is on the Trent Canal waterway connecting Georgian Bay with Lake Ontario, it supports a good fishery (perch, bass, pike, maskinonge) and is a popular area for cottagers, campers and swimmers. It was therefore felt that a macrophyte assessment, similar to the one completed on Lake Simcoe, would provide important information that could be used in understanding the Lake and in developing sound management policies for the aquatic resource.

In order to provide continuity and to facilitate comparisons between Lake Simcoe and Lake Couchiching, the same field procedures were employed in assessing macrophyte abundance and species composition.

DESCRIPTION OF STUDY AREA

Lake Couchiching is situated about 130 km (80 mi) north of Toronto, on the north end of Lake Simcoe. The lake has an area of about 49 km^2 (19 mi^2) with a shoreline of 45 km (28 mi).

In the southern end of the lake, the predominant underlying bedrock is limestone, while in the north end the bedrock is granite which is typical of the Precambrian Shield. The occurrence of limestone in Lake Simcoe and in the southern end of Lake Couchiching accounts for the moderate hardness of 120 mg/l.

Most of the bedrock in the lake is covered with a soft mud. In the northern end, there are numerous shallow areas where the bedrock is not blanketed with sediment except for small accumulations in depressions and in quiet bays.

There are several islands in the lake; the largest, Chief's Island, has an area of about 1.5 km^2 (0.6 mi^2). The other major islands are Horseshoe, Heron and Garnet. Their areas range from 60 hectares (150 acres) to 3 hectares (7 acres).

The average depth of Lake Couchiching is approximately 6m (20 ft) with the maximum depth being 12m (39 ft). The shallowness of the lake prevents any significant thermal stratification throughout the summer months and water temperatures often reach 24°C (76°F) throughout most of the lake. The warm temperatures, shallow water, relatively flat bottom profile and soft mud substrate provide a suitable physical environment for extensive macrophyte growths.

SAMPLING METHODS AND LOCATIONS

The abundance and species compositions of macrophyte communities was evaluated at 86 sampling stations (Figure 1) between July 17 and 30, 1972. Most of the stations were arbitrarily selected on a systematic basis throughout the lake. Because of the shallow nature of the lake, the majority of stations were placed on transects running west to east across the lake about 1.5 km (1 mi) apart. The transects were labelled with the "a" or first station on the west shore, going through b, c, d, etc., until the east shore was reached. The transect stations typically were 0.4 km (0.25mi)to 0.8 km (0.5 mi) apart.

In the southern end, and other shoreline areas where heavy plant growth was observed, stations were added as the study progressed. Stations were also placed around Chief's Island, Horseshoe Island, Heron Island and Garnet Island. Investigations of smaller islands were deleted owing to time limitations.

The "added" stations, as well as the first and last stations on the transects, were selected in a water depth of 2 to 4 meters which was normally the depth supplying optimum conditions for growth. Very shallow areas which supported emergent plants (i.e. Scirpus and Typha) were not surveyed owing to the size (6m, 60 hp outboard) of boat used, preventing shallow water access. However, the locations and sizes of predominant Scirpus beds were roughly charted as the survey progressed.

At each station, the boat was anchored and one or two divers entered the water and examined the macrophyte production within a five-meter radius of the boat. Specimens of each of the plants present were collected and identified. If field

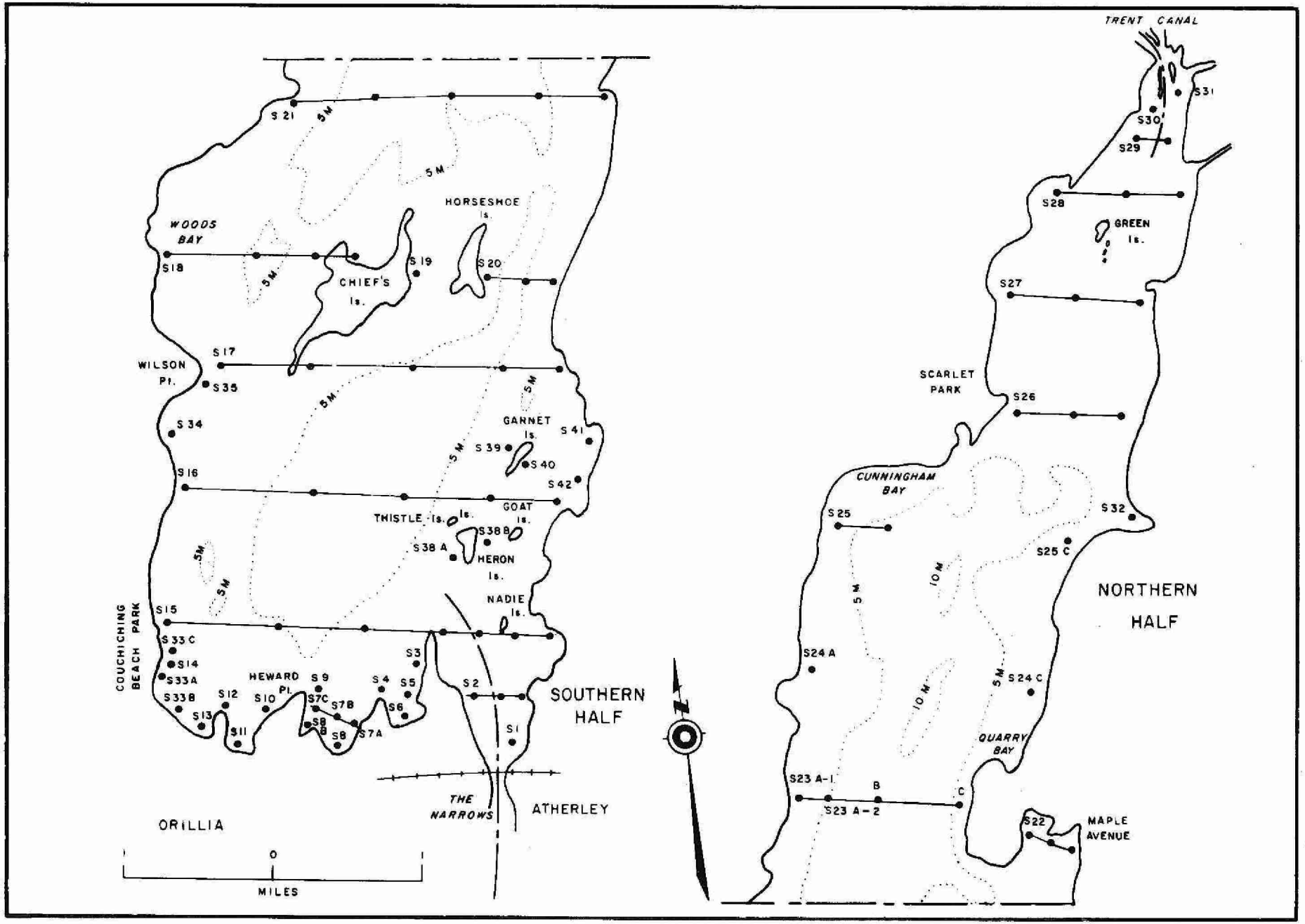

FIGURE 1. Lake Couchiching showing sampling stations and depth contours.

identification was not possible, the specimen was *fixed, preserved in a 4% formaldehyde solution and returned to the laboratory for identification. Specimens were identified according to Fasset (1969) and Prescott (1960). Nomenclature is that of Fasset.

Each species within the circle was recorded and its density estimated. A density code similar to the one used in the MilwaukeeRivershed Lakes (Modlin 1970) and the same as the one used in "Aquatic Weed Growths in Lake Simcoe" (Millard and Veal, 1971) was used. Each species was given a density number according to the following code:

I - Heavy growth: plants formed continuous coverage over the sample area with little space between individuals.

II - Moderate growth: plants occurred in dense patches or clumps with large spaces between the clumps.

III - Scattered growth: scattered growth with varying distances between individuals. Perhaps the odd dense clump. More than 15 plants

IV - Occasional growth: plants not common, usually less than 15 plants.

A total percent bottom cover was also estimated at each station.

Since density coding and percent cover estimations were made by several individuals, the divers compared observations at several stations in order to minimize subjective error.

* Fixing solution consisted of 120 cc commercial formalin, 26 cc glacial acetic acid, 4000 cc 50% alcohol, saturated with cupric acetate (25 g/1).

RESULTS

Table 1 illustrates that eleven families with thirteen genera and twenty-three species were found in Lake Couchiching.

The lack of fruiting bodies on many of the aquatic plants prevented identification to the species level. As a result, these plants were only identified to genera (e.g. Utricularia, Ranunculus and Scirpus).

Because of the many taxonomic levels involved in the ensuing discussion, the term plant type will collectively represent genus and species. The common name of each plant type will normally be used (i.e. milfoil, coontail, etc.).

Table 2 represents a complete list of all macrophytes identified with their common names, the number of stations at which they were found, the percent frequency of occurrence, and the abundance value which is explained in Table 2. Pictures and descriptions of some of the more common plants are contained in Appendix I. Appendix II provides data on the plant types and their density ratings at each of the 86 sampling locations.

The alga chara was found to be the most abundant macrophyte. It was found at 74% of the stations and had an abundance value of 72%. Chara grew in thick mats up to 15 cm. deep on a variety of substrates. Soft organic mud seemed to be the most conducive to luxuriant chara beds. It must be noted, however, that chara also grew on coarse silts, gravels and in water up to 8m deep. Bushy pondweed was often found in association with chara, especially in shallow water 2-3m deep.

Tapegrass or wild celery rated second in abundance. It occurred at only 55 stations (64% of the total) and had an abundance value of 57%. Tapegrass was found only in association with

TABLE 1: A listing of all the families, genera and species found in Lake Couchiching.

FAMILY (SCIENTIFIC NAME)	FAMILY (COMMON NAME)	GENUS	SPECIES (SCIENTIFIC NAME)	SPECIES (COMMON NAME)
Halorgidaceae	water milfoil	Myriophyllum	verticillatum	
			exalbescens	
Characeae	chara	Chara	aspera	
Najadaceae	pondweed	Potamogeton	amplifolius	big leaf pondweed
			richardsonii	richardson's pondweed
			zosteriformis	narrow leaf pondweed
			gramineus	variable pondweed
			pectinatus	sago pondweed
			crispus L.	curly leaf pondweed
			pusillus L.	slender pondweed
			praelongus	whitestem pondweed
			angustifolius	
			robbinsii	robbin's pondweed
		Najas	flexilis	bushy pondweed
Lentibulariaceae	bladderwort	Utricularia		bladderwort
Hydrocharitaceae	frogbit	Vallisneria	americana (Michx)	tapegrass
		Anacharis	canadensis	canada waterweed
Ceratophylaceae	hornwort	Ceratophyllum	demersum	coontail

TABLE 1: Continued

FAMILY (SCIENTIFIC NAME)	FAMILY (COMMON NAME)	GENUS	SPECIES (SCIENTIFIC NAME)	SPECIES (COMMON NAME)
Ranunculaceae	water buttercup	Ranunculus		
Pontederiaceae	Pickerel weed	Heteranthera	dubia	water star grass
Eriocaulaceae	pipewort	Eriocaulon	septangulare	pipewort
Cyperaceae	sedge	Scirpus	not determined	bulrush
Typhaceae	cattail	Typha	latifolia	common cattail

TABLE 2: Aquatic macrophytes found in Lake Couchiching, the number of stations where they were found, the frequency of their occurrence and abundance values.

Scientific Name	Common Name	No. of stations where found	*Frequency of Occurrence (%)	Abundance value (i.e. % of total stations where density rating was I, II or III
Myriophyllum	milfoil	68	79	34
Chara	chara	63	74	72
Vallisneria americana (Michx.)	tapegrass and wild celery	55	64	57
Najas flexilis (Willd.) Rostk & Schmidt	bushy pondweed	45	52	41
Potamogeton amplifolius (Tuckerm.)	big leaf pondweed bass weed	36	42	29
Utricularia	bladderwort	26	30	12
P. richardsonii (Benn.)	richardson's pondweed	24	28	18
Anacharis canadensis (Michx.) Planchon	canada waterweed or elodea	21	24	19
P. zosteriformis	flat-stemmed pondweed	21	24	14
P. gramineus L.	variable pondweed	15	18	14
P. pectinatus L.	sago pondweed	11	13	7
P. crispus L.	curly-leaf pondweed	11	13	10
P. pusillus L.	slender pondweed	9	10	3

* Frequency of occurrence refers to the percent of the total number of stations (i.e. 86) where the plant was found.

Table 2 - Cont'd.....

Scientific Name	Common Name	No. of stations where found	*Frequency of Occurrence (%)	Abundance value (i.e. % of total stations where density rating was I, II or III
Ceratophyllum demersum L.	coontail	6	7	2
Ranunculus spp.	water buttercup	5	6	3
P. praelongus (Wulf.)	whitestem pondweed	5	6	2
P. angustifolius (Berchtold & Presl.)		4	5	3
P. robbinsii (Oakes)	robbin's pondweed	2	2	1
Heteranthera dubia (Jacq.)	water star grass	1	1	0
Eriocaulon septangulare (with.)	pipewort	1	1	1

a fine organic mud substrate. It was especially prolific in the area adjacent to Couchiching Beach Park and the Orillia municipal docks.

Milfoil was the most widely distributed plant form, being found at 68 of the 86 stations. However, its abundance value was only 34%. Milfoil grew in shallow and deep water (up to 8m) on a variety of substrates including sandy gravel and coarse silts.

The pondweed family (i.e. genus Potamogeton) encompasses several species and while individual species were less prevalent than the three aforementioned plant types, this family as a unit did have a relatively high rate of occurrence and density. There was at least one type of pondweed at 62 of the 86 stations (72% frequency of occurrence), with at least one species having a density rating of I, II or III at 46 stations (54% abundance value). The pondweeds were found predominantly on soft mud substrates and in some of the coarser silts; very few specimens were found growing on gravel or sand substrates.

Figure 2 illustrates the over-all density of vegetation throughout Lake Couchiching. It must be pointed out that because of the limited number of sampling locations (86), the figure lacks detailed accuracy. However, the main purpose of the study was to gain an appreciation of the over-all abundance and composition of vegetation in the lake, rather than defining the conditions at any given location.

Most of the shallow water (less than 8 meters, see Figure 1) areas supported heavy growths (75-100% coverage, see Figure 2) with the deep areas (8-12 meters) having very limited growth (0-25% coverage). A considerable difference was noted between the north and south ends of the lake. The shallow water and thick mud sediment in the south end, particularly in the area of The Narrows, provided an ideal habitat for dense macrophyte beds with a wide variety of species. The north end,

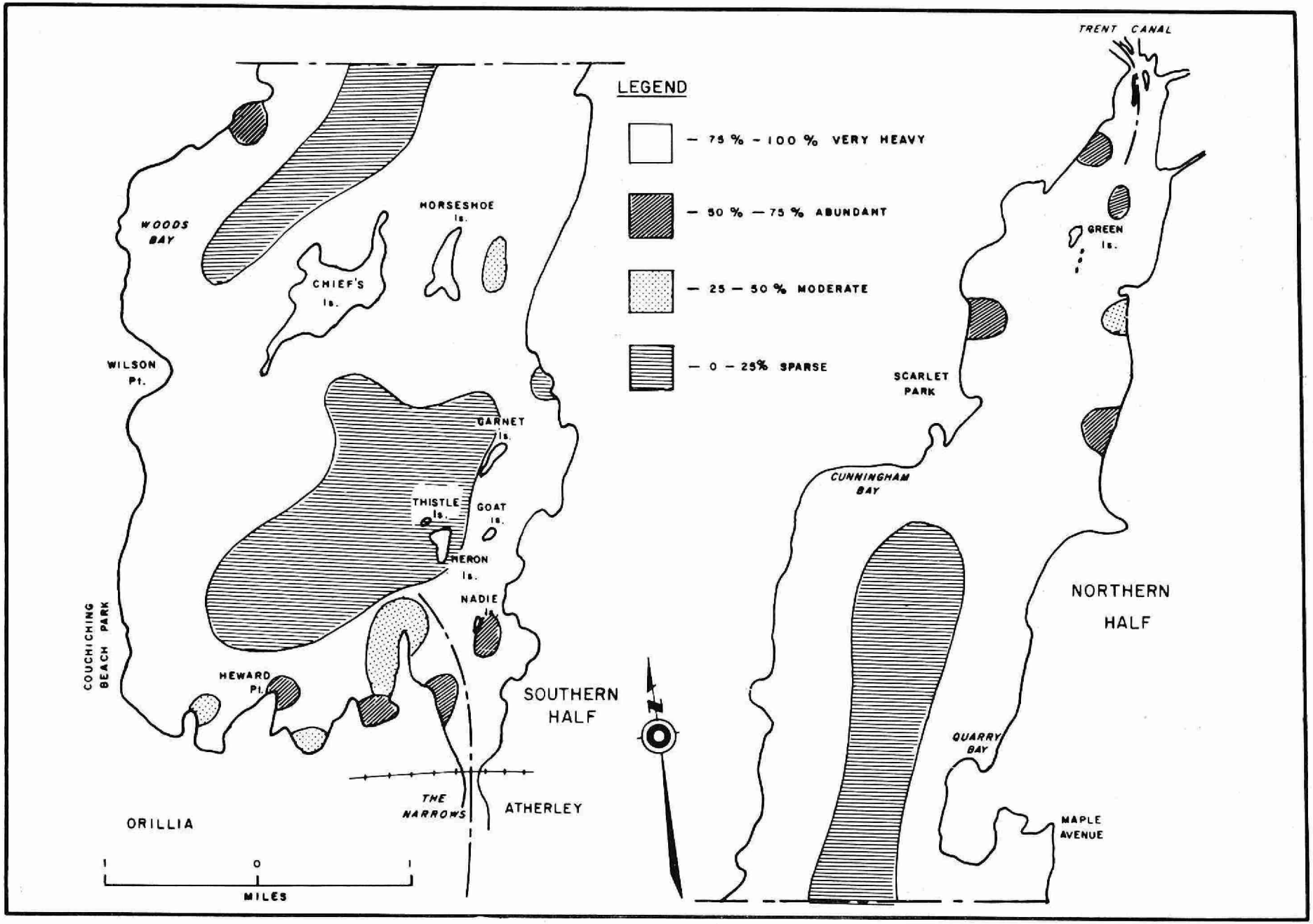

FIGURE 2. Lake Couchiching, showing bottom coverage by macrophytes.

however, is characterized by many areas of exposed granite bedrock and the macrophytes are restricted to areas where some accumulation of sediment has materialized.

Chief's Island, with its large shallow area to the south-west and sheltered bays to the north and east, was another area conducive to dense macrophyte growth. Heron Island, on the other hand, with its exposed position and gravel bottom surrounding it, was almost void of macrophytes. Garnet Island was void of growth on the rocky western side (exposed to prevailing westerly winds); however, the protected east side had a soft mud bottom and 90% macrophyte coverage.

Figure 3 illustrates the locations of major bulrush beds. The mapping of these beds was ancillary to the main study and the figure is not complete since it was drawn as a result of casual field observations. However, it does outline major bulrush beds which were found in shallow water (1-2.5m) with soft mud substrates.

DISCUSSION

One interesting aspect of the vegetation pattern in Lake Couchiching is that while production is moderately high throughout much of the lake, nuisance conditions resulting from over-production are negligible. Records maintained by the Ministry reveal that during 1972, there was only one approved herbicide treatment and this was for a quarter-acre area in The Narrows area of Lake Couchiching. This indicates that plant growths do not present significant problems to the many cottagers who use the lake for their summer retreat.

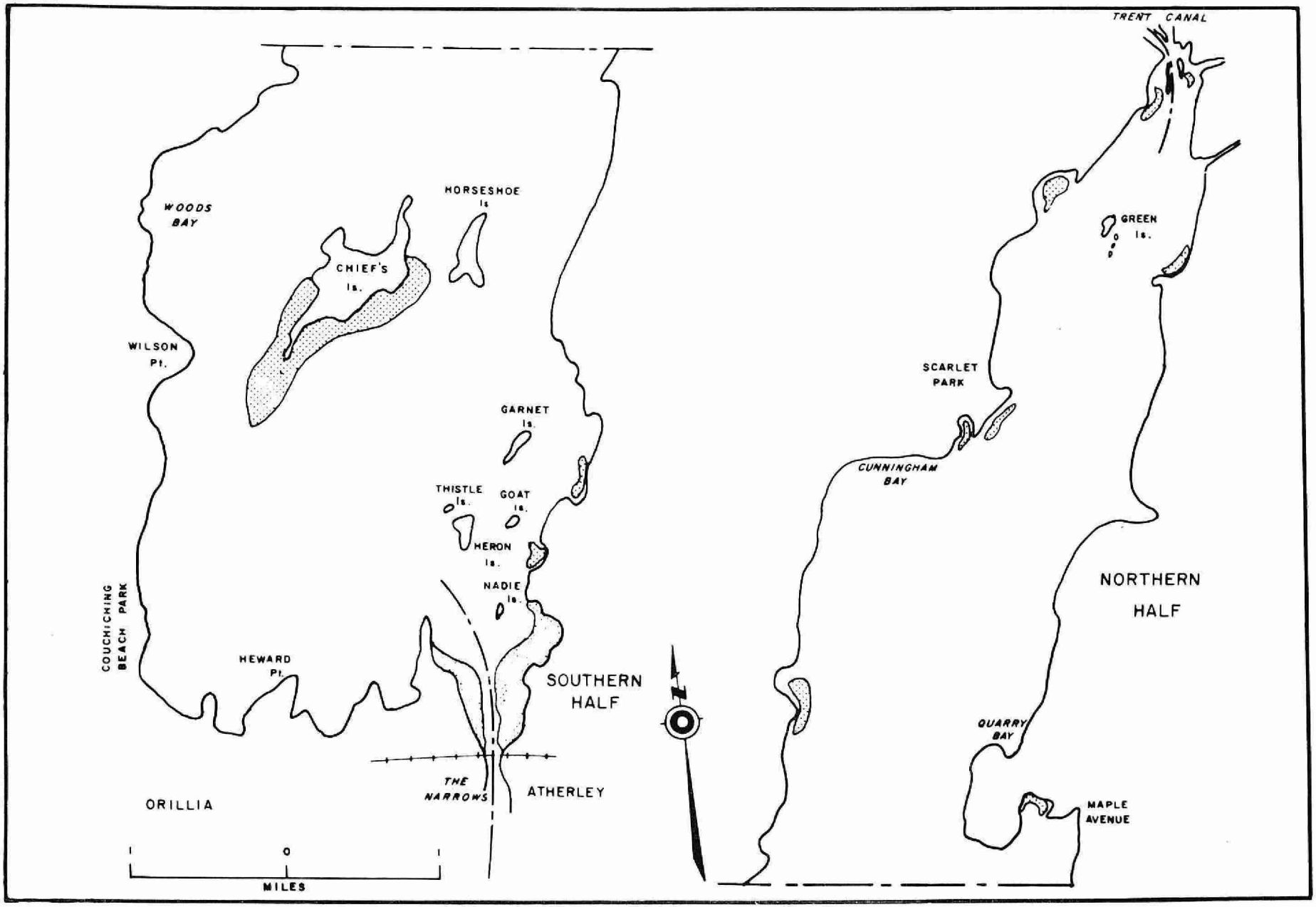

FIGURE 3. Lake Couchiching, showing locations of major Scirpus beds.

While no attempt was made in the present study to determine the role and significance of macrophytes to the overall ecology of the lake, the authors suggest that the existing weed growths appear to represent ideal conditions.

Firstly, Lake Couchiching supports a good sport fishery including several species (e.g. pike, maskinonge) that require vegetated areas for the maintenance of a successful population. Secondly, the extent of macrophyte growths, together with the small standing crop of phytoplankton (phytoplankton density, measured by the chlorophyll 'a' test, was normally less than 3 mg/m^3) indicates that there may well be a successful and ecologically desirable competition between the two levels of plant communities. The nutrient qualities of the lake are very similar to those found in Lake Simcoe (the only significant water input is from Lake Simcoe) - *0.02 mg/l total P and 0.4 mg/l total N. The waters are therefore able to support only limited plant growths and competition for limiting plant nutrients (e.g. N, P) can be expected to be severe. In Lake Simcoe, macrophyte production is restricted to a very narrow shoreline band around the perimeter of the lake and it is obvious that the beds of vegetation are not large enough to compete significantly with the phytoplankton for nutrients (except for competition in some local areas - e.g. Cook Bay). This is unlike the situation in Lake Couchiching where macrophytes can be found practically throughout the lake. It is also interesting to note that unlike Lake Couchiching, blooms of blue-green algae materialized on Lake Simcoe during 1971 and 1972 and it is suggested that the competitive nature of the macrophytes in Lake Couchiching may have **prevented the development of a bloom.

* Levels in Lake Simcoe proper are also 0.02 mg/l total P and 0.4 mg.l total N.

** To the authors' knowledge, an algal bloom has never developed on Lake Couchiching.

While the physical and geographic features of Lake Couchiching are favourable to macrophyte growths (unlike Lake Simcoe) because of the shallow, flat bottom profile, the extensive areas of soft mud substrate and the warm water temperatures, tne actual variety of plant types and the community structure within hydrophyte beds are very similar between the two lakes.

Not unlike Lake Simcoe, chara was the most abundant macrophyte. It was found in both shallow and deep water, and grew from a variety of substrates. It was, however, more prevalent in shallow water on a soft mud substrate. It appears that chara is highly adaptable to a wide range of environmental conditions. This macrophyte has been shown to play an important role in fresh water ecology by supporting many aquatic animals and by controlling the growths of other macrophytes through smothering (Pirnie, 1935). Metcalf (1931) reported that chara is useful as a duck food, and the value of this alga in keeping bottom waters cool for trout and in harbouring food for bass and trout has long been recognized. Another interesting feature of chara is that it tends to soften hard water by abstracting lime and carbon dioxide to form marl (Titcombe, 1909).

Tapegrass, another prevalent macrophyte in Lake Couchiching had a definite preference for soft mud substrates. It nas been shown to be an excellent duck food (Kubichek, 1933) and a valuable fish food (McAtee, 1917).

Milfoil, like chara, showed a great versatility in growing on all types of substrates and in both shallow and deep water. Its ability to grow in a variety of environments accounts for its distribution throughout Lake Couchiching. Although milfoil is not a commonly used food, it does provide shelter and attachment surfaces for aquatic invertebrates.

The pondweeds (i.e. species of the genus Potamogeton) were found only on soft mud substrates, probably because the mud provided good anchorage for these tall plants. Pond weeds are used as food by ducks, marsh birds and muskrats (Hicks, 1932). They also provide shelter and food for fish as well as having a water softening effect (Aldrich, 1937) similar to chara.

It is obvious from the above information that the fish and wild fowl populations of Lake Couchiching are supported by its macrophyte growth. Because of this, great care must be taken in aquatic nuisance control and in formulating a management plan which will maintain the ecological balance and yet optimize water resource utilization. If plant harvesting or clearing is necessary, it should be undertaken in limited areas with strict procedural controls being followed.

PLANT CONTROL

There are several methods available for aquatic plant control. The fastest, least expensive and most efficient is chemical treatment. Although the initial effectiveness of chemical treatment is readily apparent, problems can result. Little is known about the persistence of aquatic herbicides in water, fish and sediments. The dangers of the herbicide entering a private water supply is also of concern. In open shoreline areas, controlling the size of the treated area is difficult because of water movements and overdoses to compensate for this dispersion, or a miscalculation, can lead to the death of fishes and invertebrates. Because of these factors, the use of aquatic herbicides is government-regulated through a *permit system.

* Permit application forms may be obtained by writing to:

The Ministry of the Environment
Biology Section
P.O. Box 213,
Rexdale, Ontario

Mayhew and Runkel (1962) as well as Schenk (1965) had considerable short term success (one season) inhibiting macrophyte growth using black polyethylene sheets. Areas as large as 324 m^2 were treated in early spring by covering the bottom or having the sheets floating just below the surface. Leaving the sheets in position for up to 20 days resulted in inhibited growth until late September.

Other mechanical methods such as underwater cutters, chains, air jets, rakes and dredging all remove aquatic plants but necessitate secondary handling of the cut plants.

Probably the most promising method for managing aquatic macrophyte growths is the mechanical underwater cutter. Sophisticated cutters are presently on the market which can both cut and remove the plants. Repeated "harvests" can prevent nuisance conditions from developing and also remove organic and nutrient materials from the aquatic environment. Research is presently underway within the Ministry to determine the ecological relationship between macrophytes and other components of the biota such as fish and invertebrate life. Results of these studies hopefully will be used in the future for local areas in Lake Couchiching where a need develops for aquatic vegetation control without altering the favourable balance which now exists.

SUMMARY

1. Lake Couchiching supports a large standing crop of aquatic macrophytes. Throughout most of the shallow-water area (<8 meters) 80-100% of the bottom was covered with plants; the overall average coverage for the lake would be about 50%.

2. Milfoil, tapegrass, chara and the pondweeds constituted the major plant types.

3. The heaviest plant growth occurred in shallow water (2 meters) with soft mud substrates.

4. Although the vegetation is quite heavy, there are practically no areas that are "choked" with excessive macrophytes; existing plant growths at present do not constitute a nuisance problem.

RECOMMENDATIONS

1. The existing plant population should be left mainly unharvested in order to promote optimum fish and wildlife populations.

2. Where local situations necessitate control, mechanical means such as plant harvesters should be encouraged.

3. Dredging permits for Lake Couchiching should be issued only if there is no danger of problems resulting from floating macrophytes at the disposal site. Because of the widespread occurrence of macrophytes in shallow water, land disposal of dredgings may be required for most dredging operations.

ACKNOWLEDGEMENTS

To Mr. A.R. Clark who managed the field duties, and to Mr. G. Black who did a great deal of the sampling, and photographed the specimens.

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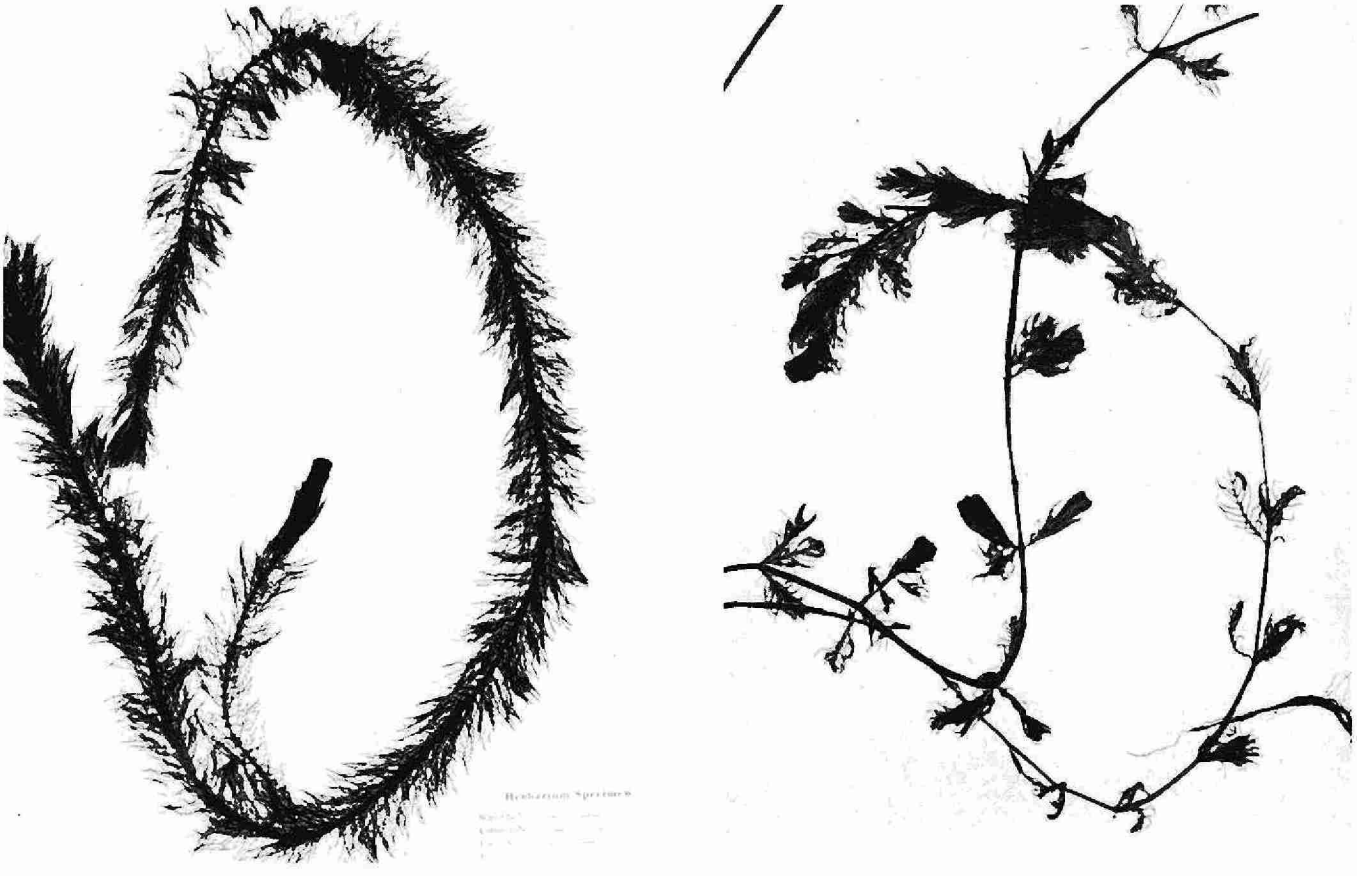
APPENDIX I: Descriptions and photographs of major plant types. Plant descriptions from Lawrence and Weldon,"Obnoxious Aquatic Plants Affecting Water Resources" 1966.

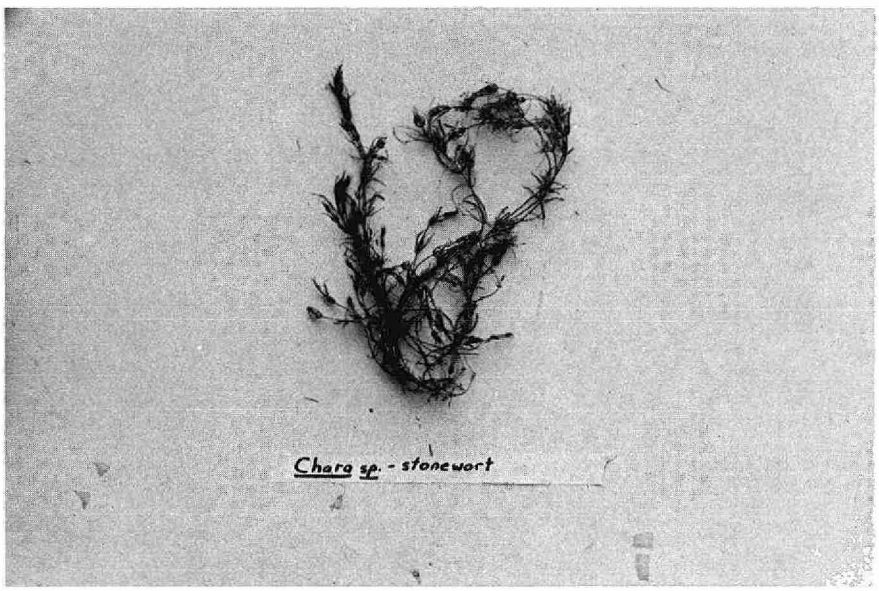
A) Milfoil — Perennial aquatics, submersed with slender sparingly branched stems, rooting freely at lower nodes. Leaves whorled, variable; pinnately dissected into Filiform segments to those reduced to bracts leaf dissection variable from submersed to emersed form. Flowers very small born either in axils of emersed leaves, or bracts. Well distributed throughtout Canada.



Milfoil (Myriophyllum)

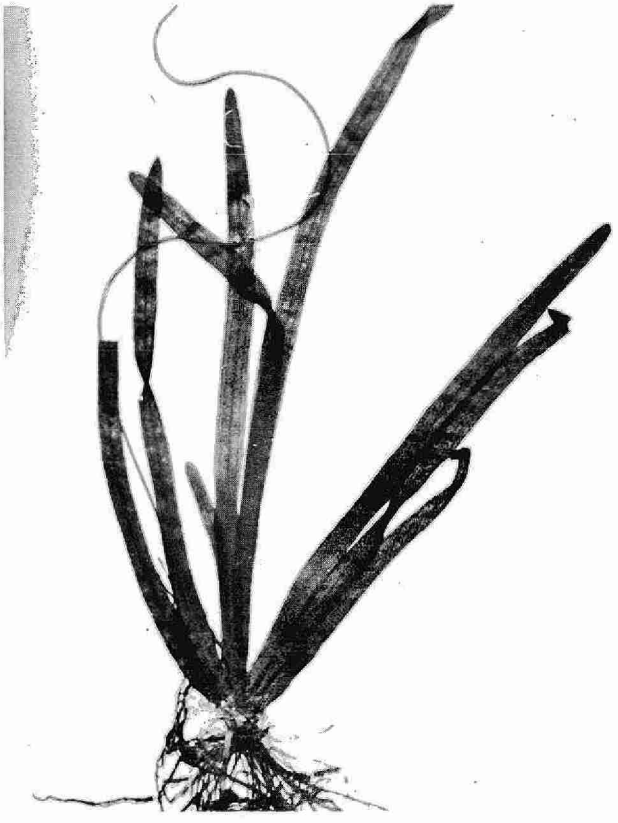
a. M. verticillatum
b. M. excalbescens

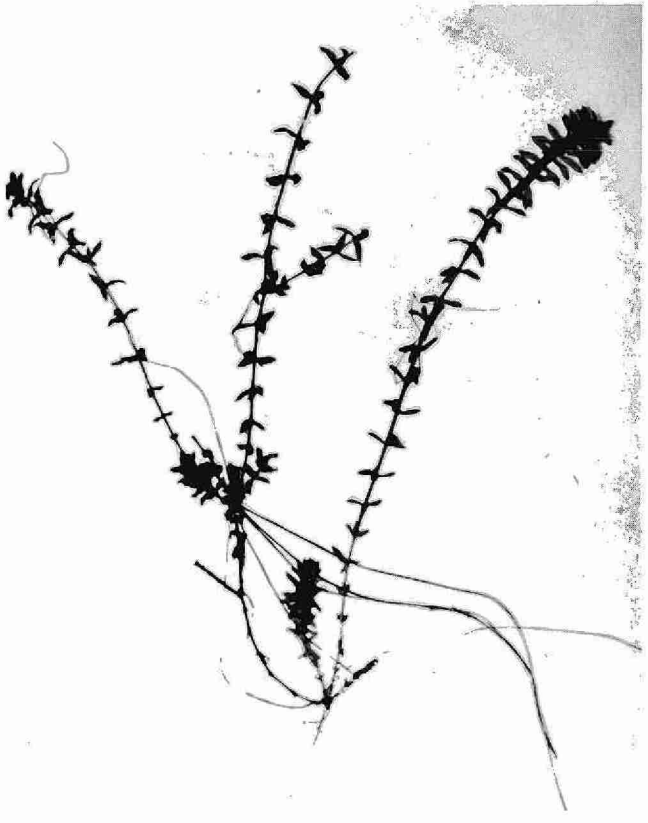
B) Chara: Plants large, erect, stemlike. Whorled branches and forked leaves that are rough to the touch (often lime encrusted). Crushed plants produce a musk-like odour. Almost always in hard water.



Chara Chara aspera

C) Frogbit Family: Perennial, slender-stemmed, branching submersed aquatic plants, with whorled thin linear leaves and fibrous roots, or submersed plants with clusters of leaves at nodes of rhizomes. Flowers borne on peduncle above surface of water.



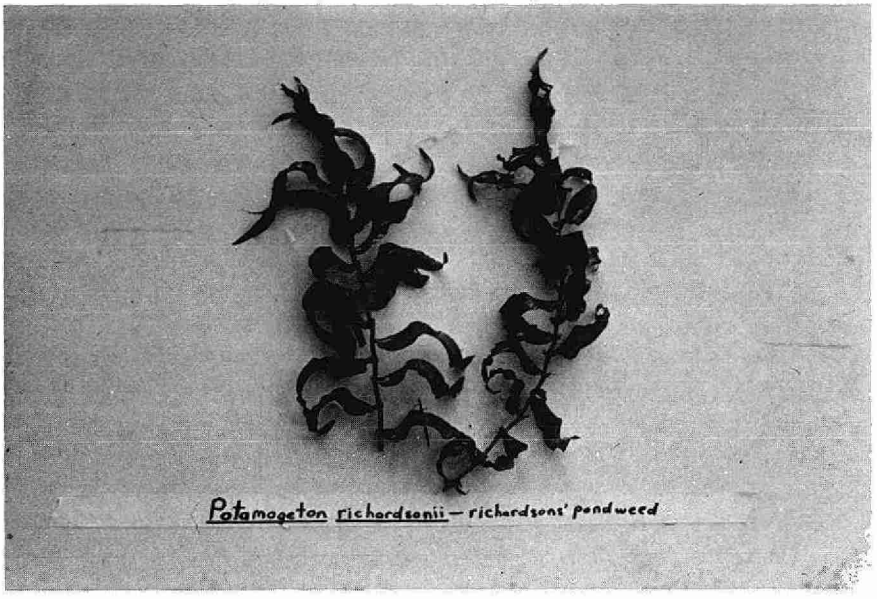


Tapegrass Vallisnaria american Canada Water weed
Anacharis canadensis

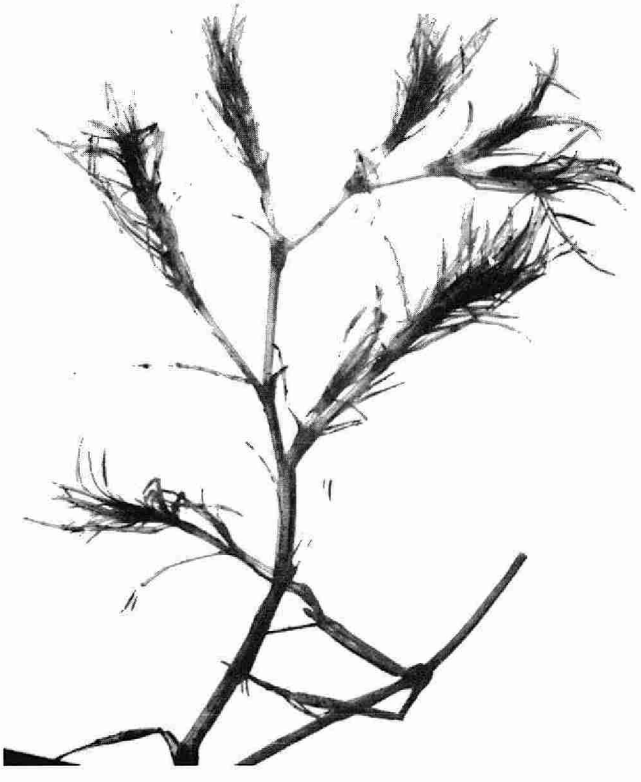
D) Pondweeds

Found in fresh or brackish waters, submersed aquatic plants with creeping rootstocks. Leaves mostly alternate, may be opposite on erect jointed stems. Leaves all alike or may be two kinds; all submersed or some of them floating. Submersed leaves thin and linear or all broad. Emersed leaves broad more or less elliptical and petioled. Seed heads small and crowded into spikes. Spikes raised to surface on long peduncle and/or submersed on short peduncle. Winter buds produced in axils of leaves of some species. Creeping rootstock of other species may terminate in tubors. The largest family of truly aquatic plant, widely distributed throughout Canada.

Bass weed P. amplifolius

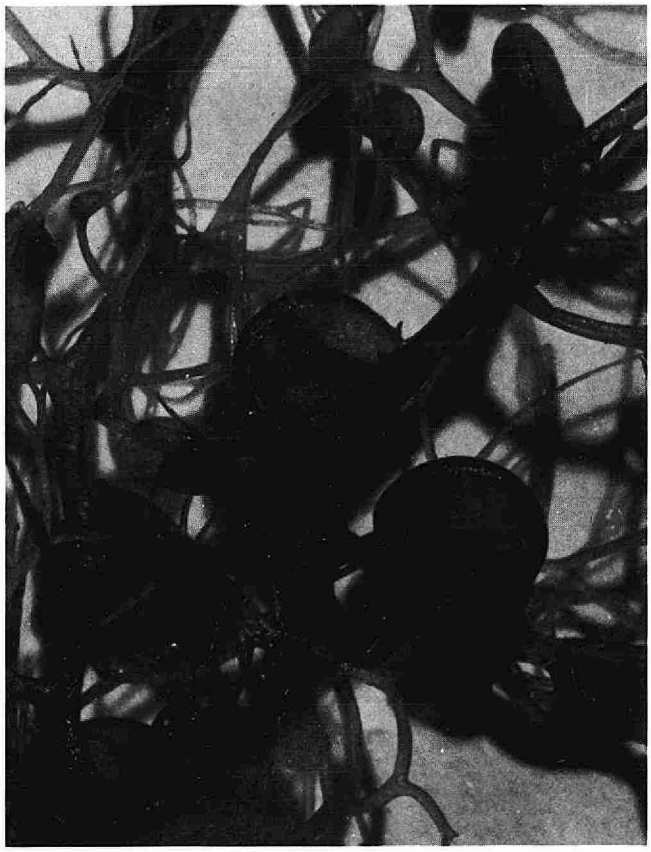


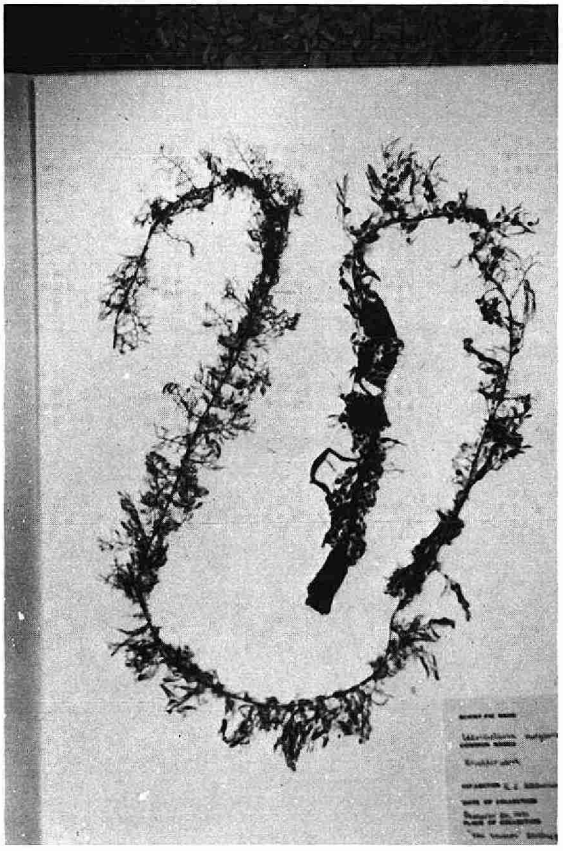
Richardson's Pondweed P. Richardsonii



Bushy Pondweed Najas flexilis

E) BLADDERWORT FAMILY: Submersed or floating rootless plants with flaccid finely dissected or filiform simple leaves. Many of the leaf segments with small bladders that have little trap doors. These bladders may trap small aquatic animals (amphipods, midges) which are digested and serve as partial nourishment for the plant. Solitary flowers appear above the water on short erect peduncle and are either yellow or purple.





Bladderwort Utricularia spp.

APPENDIX II: A TABULATION OF THE VARIETY AND DENSITY OF PLANTS FOUND AT EACH SAMPLING LOCATION

PLANT TYPE	SAMPLING LOCATIONS AND DENSITY RATINGS																			
	1	2a	2b	2c	3	4	5	6	7a	7b	8	8b	9	10	11	12	13	14	15a	15b
Anacharis canadensis	I		III		III						IV					III	III	III		
Ceratophyllum demersum	IV		III																	
Chara		II	II	I	II		III	II		I	II	II	II		II	III			I	
Eriocaulon septangulare																				
Heteranthera dubia																				
Myriophyllum	II	III	III	II	III	IV	IV	IV	IV	III	II	III	IV		IV	III	III	III	IV	IV
Najas flexilis			IV					IV		IV		II		III		III		III		
Potamogeton amplifolius	III			III				IV		IV		III			III			III	III	
angustifolius																				
crispus								IV				III								
gramineus																				
pectinatus								IV				III					II			
praelongus																				
pusillus								IV						II	IV					
richardsonii	II							IV							III		III	II		
robinsii														III						
zosteriformis	III		III	III			IV										III	III		
Ranunculus	II		III														III			
Utricularia		III	III	III							IV	IV				III		III		
Vallisneria americana	IV	III	II	III				IV		III		II	III	I	III		I	I	III	

APPENDIX II - Cont'd.....

PLANT TYPE	SAMPLING LOCATIONS AND DENSITY RATINGS															
	15c	15d	15e	15f	15g	16a	16b	16c	16d	16e	17a	17b	17c	17d	17e	18a
Anacharis canadensis			III						III	IV				III		
Ceratophyllum demersum								IV					IV			
Chara		II	II	I	II	I	II		III	II	I	I		II		II
Eriocaulon septangulare																
Heteranthera dubia																
Myriophyllum	IV	IV	III		III	III	IV			IV		IV		III	IV	IV
Najas flexilis			IV			III			IV	II				III	III	III
Potamogeton amplifolius			III		III		III			III				III		III
angustifolius																III
crispus				III					III							
gramineus																
pectinatus																
praelongus																
pusillus										III	IV					
richardsonii					III	IV	III		III	IV	III					
robinsii																
zosteriformis			III			IV			III							
Ranunculus																
Utricularia			III		III				III	IV						
Vallisneria americana			III	III	III	II			III	II	III			III		III

APPENDIX II - Cont'd.....

PLANT TYPE	SAMPLING LOCATIONS AND DENSITY RATINGS															
	18b	18c	18d	19	20a	20b	20c	21a	21b	21c	21d	21e	22a	22b	22c	$23a_1$
Anacharis canadensis						III				°		III				
Certophyllum demersum						IV										
Chara		II	II	II			II	II		II	I	III	II	II	I	I
Eriocaulon septangulare																
Heteranthera dubia																
Myriophyllum		IV	IV	IV	III			IV	IV	IV		IV	II		IV	
Najas flexilis		IV		I		III	III			IV	IV	II	III			
Potamogeton amplifolius		IV	III	IV		IV	IV			III	III	III		III	IV	
angustifolius												III				
crispus		IV	III		III							III	III	III		
gramineus				III												
pectinatus					II						IV					
praelongus			IV							III						
pusillus															IV	
richardsonii												III	III			
robinsii																
zosteriformis				IV		IV		IV					III			
Ranunculus																
Utricularia		IV					IV							III		
Vallisneria americana		III	III	IV	II	III	II			IV	III	III	III	III	III	IV

APPENDIX II - Cont'd.....

PLANT TYPE	SAMPLING LOCATIONS AND DENSITY RATINGS															
	$23a_2$	23b	23c	24a	24c	25a	25b	25c	26a	26b	26c	27a	27b	27c	28a	28b
Anacharis canadensis	IV								III				III		IV	
Ceratophyllum demersum																
Chara	II			I	II	II		III	II	II	II	II	II	IV	III	I
Eriocaulon septangulare						III										
Heteranthera dubia	IV															
Myriophyllum	II	IV	IV	IV	IV			IV	III	III	IV		IV	III	III	III
Najas flexilis	III		IV	III	II					III		III	IV		II	II
Potamogeton amplifolius	III			IV					III	III			III		III	
angustifolius											IV					
crispus	III															
gramineus					III	II						IV	III	IV		III
pectinatus				IV	IV	III										
praelongus																
pusillus					IV											
richardsonii	III								III	IV					III	
robinsii																
zosteriformis	III		IV	IV	IV											
Ranunculus																
Utricularia				IV												IV
Vallisneria americana	III			IV	IV				III			III	III		III	III

APPENDIX II - Cont'd....

PLANT TYPE	SAMPLING LOCATIONS AND DENSITY RATINGS																	
	28c	29a	29b	30	31	32	33a	33b	33c	34	35	36	38a	38b	39	40	41	42
Anacharis canadensis							III	III				III						iv
Ceratophyllum demersum								iii										
Chara	II	II	I	II	II	II			III	II	II	II				I	I	I
Eriocaulon septangulare																		
Heteranthera dubia																		
Myriophyllum	IV	III	IV	III		IV	III	III	IV	III	IV	III		IV		IV	IV	IV
Najas flexilis	III	II	III	II		I	I	III	II	III	I	III				II	III	III
Potamogeton amplifolius		III				III			IV	III						IV	IV	
angustifolius																III		
crispus																		
gramineus		III	III	III	III					III	III						III	IV
pectinatus		II					IV	III										
praelongus									IV		IV	III						
pusillus							IV	III										
richardsonii		III				IV	IV	IV		IV	IV	III						
robinsii						IV												
zosteriformis						III	III	III			IV							
Ranunculus							IV	IV										
Utricularia	IV	IV			IV	IV	IV	III		IV	IV					IV		IV
Vallisneria americana	III	III	III	III		II	I	I	I	II	III	II				III	II	